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Mar 1, 1917

FIRST ANNUAL REPORT
OF THE
STATE CHIEF ENGINEER
FOR THE
STATE OF WISCONSIN

JOHN G. D. MACK,
State Chief Engineer.

17-27472

MADISON, WIS.
March 1, 1917.

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TO HIS EXCELLENCY

THE GOVERNOR OF THE STATE OF WISCONSIN :

In accordance with the provisions of the law creating the department of engineering, I submit herewith a report on the work of this department.

On account of the fact that less than ten months of the bien-nium remained after the organization of the department, it was necessary to include certain data from the latter part of the calendar year 1916 in order to show more clearly the scope of the department's work.

Respectfully submitted,

JOHN G. D. MACK,

State Chief Engineer.

REPORT OF THE STATE CHIEF ENGINEER

March 1, 1917

The law creating the department of engineering for the state of Wisconsin, Sec. 1636—250 Wisconsin statutes, 1915 (See Appendix), was passed August 7, 1915.

The writer was appointed state chief engineer September 6, 1915, and immediately began the organization of the department.

At this time the only engineering departments of the state were:

The joint engineering staff of the tax and railroad commissions.

The engineering staff of the highway commission, each of which had been in existence for some years.

The engineering staff of the Wisconsin tax commission was organized in 1903, under Professor W. D. Taylor who resigned in July, 1905, to become chief engineer of the Chicago and Alton railroad. The railroad commission was formed in 1905. The engineering staff then became the joint staff of the tax and railroad commissions. Professor W. D. Pence was appointed engineer of both commissions in July, 1906, and in May, 1913, resigned to become member of the engineering board, division of valuation, interstate commerce commission, being succeeded by Mr. C. M. Larson, formerly assistant engineer.

The state highway work was commenced in July, 1907, under the direction of Mr. W. O. Hotchkiss, chief of the highway division of the Wisconsin geological and natural history survey. Until the creation of the Wisconsin state highway commission in 1911, under the general highway law, which permitted state aid in road construction, the highway work continued under direction of this department.

The highway engineering staff dates from the appointment of Mr. A. R. Hirst as highway engineer in September, 1907. In 1908, Mr. M. W. Torkelson was appointed bridge engineer.

With the greatly increased amount of highway construction under the commission, the highway engineering staff was enlarged to meet the demands made for the design and supervision of the construction of roads and bridges.

Assistance was given the state board of health in sanitary surveys and bacteriological investigations by Professor H. L. Russell from the date of his taking charge of the department in bacteriology at the university in 1893. The state laboratory of hygiene was es-

tablished at the university in 1903 as the laboratory of the state board of health, Professor Russell being director until 1907, when he became dean of the college of agriculture. During the period 1895 to 1903 chemical analyses as required by the state board of health were made by Mr. A. S. Mitchell, consulting chemist to the state dairy and food commission.

From the organization of the state hygienic laboratory, sanitary surveys have been made by the laboratory staff. Mr. E. J. Tully joined the staff in 1909, since which time he has had direct charge of this work. Mr. W. G. Kirchoffer has been consulting sanitary engineer continuously since 1904 for the state board of health and for the state board of control.

For some years the electrical engineering department of the college of engineering, University of Wisconsin, had maintained a set of standards for electrical measurement, which were used by the electric service inspectors in maintaining the service standards fixed by the railroad commission. In 1913, the railroad commission and the university board of regents established a joint standards laboratory at the university, in charge of Mr. F. A. Kartak. This laboratory works in close coöperation with the federal bureau of standards at Washington.

The members of these staffs had performed a considerable amount of engineering and sanitary service for state departments other than those under which they were employed. In general, however, aside from the specific cases mentioned, the state engineering and architectural work was done by men employed for particular pieces of work, usually on a per diem or cost percentage basis.

During this time the engineering problems of the University of Wisconsin were in charge of members of the staff of the college of engineering, and engineers employed by the university architect who had charge of all architectural work of the university.

The various lines of state engineering, architectural and allied scientific work, were therefore rather widely scattered, with a tendency to become still further divergent. An effort has been made by the department of engineering to coordinate these activities, by which it is believed they can be made more effective.

ORGANIZATION OF THE DEPARTMENT

After a study of the problems to be met by the department of engineering, it appeared that it should be assembled as follows:

1. Railroad and Utilities division
2. Highway division
3. Architecture division
4. Power Plant division
5. Sanitary division

The following have been appointed as division heads: Railroad and utilities engineer, C. M. Larson, formerly chief engineer of the

joint engineering staff of the railroad and tax commissions. Appointed October 6, 1915.

State highway engineer, A. R. Hirst, formerly chief engineer of the state highway commission. Appointed September 21, 1915.

State architect, Arthur Peabody, formerly university architect, University of Wisconsin. Appointed September 21, 1915.

State power plant engineer, John C. White, formerly chief operating engineer, capitol power plant, Wisconsin state capitol. Appointed October 6, 1915.

State sanitary engineer, E. J. Tully, chemist and field sanitarian, state laboratory of hygiene. Appointed December 21, 1916.

Experience has shown that this grouping is entirely satisfactory, for with the natural subdivisions in each department and the correlation with other departments, the entire field is covered.

SERVICE BETWEEN DIVISIONS

The experience of one state department in engineering and architectural work is usually parallel and therefore helpful to other departments. One of the important results of the centralization of the state's engineering work is the ease with which transfers of men with special experience may be made to assist the various departments. Numberless examples of this point may be made from daily experience in the department.

For instance: One of the board of control institutions had to be rewired for electric lighting. This work was put in charge of a member of the service department of the railroad and utilities division, who made a study of the conditions and furnished the state architect data for specifications. The service department or the railroad and utilities division tested the old electric lighting cable, practically all of which was re-installed together with about 600 feet of old cable from one of the other institutions, inspected the construction, and made recommendations for changes in connected load to reduce the cost of current.

In another case, a steel roof structural design needed for one of the board of control institutions was made by an engineer from the bridge department of the highway division.

Again, the value of proposed land purchases for the state normal schools and university was studied by the land valuation department of the railroad and utilities division, which has made land valuations for the tax commission since 1903.

CONSULTING ENGINEERS

There are certain highly specialized lines of professional work in which only occasional service is required. For the performance of this it is not advisable to appoint members of the staff to be continuously employed. These problems may often contain elements of great danger, and for its protection the state must have the highest type of professional skill in their solution. As occasion

has required, the following consulting engineers have been appointed:

- D. W. Mead and C. V. Seastone of Mead and Seastone, consulting engineers, Madison, for consultation on the safety of the Wisconsin dam now under construction;
- W. G. Kirchoffer, sanitary and hydraulic engineer, for consultation and design on institution sewage, water supply and drainage;
- F. E. Turneure, dean, college of engineering, University of Wisconsin, for consultation on stresses in Wells street viaduct, Milwaukee;
- H. V. Tennant, consulting engineer in charge of the Portage levee construction, appointed March 27, 1916.

The appointments of consulting engineers are so made that they may be temporarily employed in any emergency requiring their services.

The work of the department of engineering may be classified under the following general headings:

1. Design
2. Inspection
3. Valuation
4. Investigation
5. Testing
6. Consultation
7. Educational

Following are illustrations of these classes:

The letter before a group indicates the division in charge of the work, although in many cases men from two or more divisions are working in coöperation.

- (a) Railroad and utilities
- (b) Highway
- (c) Architectural
- (d) Power Plant
- (e) Sanitary

DESIGN

- (a) Design of electric wiring systems
- (b) State aid roads, bridges and culverts
- (c) Buildings and other structures
- (d) Redesign of power, heating and pumping plants
- (e) Design of sewage disposal, drainage and water supply systems

INSPECTION

The items given under design are inspected during construction and where the size of the work permits, as in roads, bridges and the larger buildings, a special inspector is constantly employed. All building inspectors are provided with a daily report form so that the state chief engineer may be kept in close touch with the progress on each project.

- (a) Public utilities, gas, electric, water and heating service throughout the state is under constant inspection to maintain the quality of service.

In the inspection of the state buildings for safety in regard to fire and personal injury, the department of engineering has had the closest coöperation of the building inspector of the industrial commission and the fire prevention inspector of the insurance department.

Their inspectors have made detailed reports of their findings in all state buildings which time has permitted them to examine, These reports have been furnished to the department of engineering for consultation and the preparation of estimates for carrying out recommendations.

VALUATIONS

(a) Valuations of public utilities for rate determinations, taxation, the issue of securities, or purchase, are constantly under way for the tax and railroad commissions.

(b) A valuation of the state educational buildings was made for the state board of education.

Under valuation may be grouped the estimates of cost of construction and the reports on bids and material prices which are frequently made for various departments.

INVESTIGATIONS

The scope of investigation is wide and forms a large portion of the other classes of service but as a separate function may be illustrated as follows:

7(a)-(b) Accidents at grade crossings of a railroad and highway are investigated to determine possible relief from such accidents.

(c) A proposed building or other structure is studied to determine that it is satisfactory for the use intended, to select the best type of construction for the purpose and to fix upon the correct location.

(d) Excessive fuel consumption in a state power or heating plant, or failure to give satisfactory service, is investigated to determine cause and suggest remedies.

ROUTINE TESTING

There are many kinds of testing involved in the work of the department, of which the following are illustrations:

(a) Tests of electrical indicating and recording instruments. Tests of insulating materials and devices. Tests of candle power and illumination. Determination of electrolysis conditions. Adequacy of water pumping plants for fire protection.

(b)-(c) Tests of various building materials are made to determine whether the quality meets the specifications. Under a contract made by the highway division with a commercial organization for the testing of materials, other state departments may have tests made. This arrangement has been employed in the testing of cement and steel for use in building construction.

Materials not included in this contract are tested in the laboratories of the college of engineering, University of Wisconsin, and by the chemists of the state dairy and food department.

(d) Regular analyses of coal used at the state power plants for which coal is bought on the heat unit basis are made by commercial chemists and by the chemical engineering laboratory staff at the university, and at the capitol power plant. At the latter analyses are made, when necessary, of boiler waters used at state power plants.

(e) Analyses of water for public supplies. Tests of sewage disposal plants to determine efficiency of operation, and analyses of industrial waste in connection with stream pollution problems.

GENERAL TESTING

The work of general testing will increase as it is an important part of the investigation of many problems of a general nature which will have to be taken up by the department of engineering in order to give a substantial basis for independent judgment on the best practice to follow.

Example. Various forms of portable fire extinguishers have been tested as to their relative merits for use at state institutions and by private users. These tests were made in coöperation with representatives of the industrial commission and insurance department.

Another problem may be used for illustration, that of testing out several experimental pieces of concrete road, each of which would be of a number of different types of construction. This would give a thoroughly practical test of the best specification to use for such work, which is necessarily of high cost. Such a test, if carried out with completeness, would result in an enormous saving in future years.

CONSULTATION

One part of the work of the department of engineering is that of service as consulting engineers and architects to the other state departments having need for this service.

Many of the specific duties have already been noted under the separate headings, but the work of consultation precedes these unless in the case of the more routine work.

EDUCATIONAL

Some state departments, other than those whose function is primarily educational, have more or less work of an educational nature to perform. This may be the information of the public on the work of a department by means of bulletins, lectures and the press, or by personal presentation of information to bodies or individuals who are specially interested in some phases of a department's activity.

In the department of engineering a considerable amount of such work is done:

(a) Talks before public gatherings, civic committees, municipal officers and public utility men on service standards, principles and methods of valuation and on other subjects of interest to consumers or to those engaged in utility operation.

(b) Attendance at farmers' institutes and other groups interested in the improvement of roads in the state, to explain the best methods of road construction, maintenance and allied subjects. Under direction of the highway commission an annual road school of one week in length is held each winter at Madison. During this school period the various problems connected with highways are presented, studied and discussed. A large and carefully prepared exhibit aids in the instructional work.

(d) The department of engineering has acted in coöperation with the civil service commission and university extension division in preparing a course of instruction for employees of state power and heating plants. During the summer of 1916 the first school of state power plant employees was held, in a three days' session. Many power plant problems were presented and studied there under direction of the state power plant engineer. The general idea of this school is to increase the efficiency of the state power and heating plants. The meeting was so successful that it is recommended that this school be made an annual event.

(e) Other than the purely educational courses offered at the university, talks are regularly given before city councils, and addresses frequently made before clubs, mass meetings and various organizations in regard to water supplies and water purification, treatment and disposal of sewage, purification of manufacturing wastes and stream pollution problems.

REPORTS

A large number of special reports have been prepared during the year by the state chief engineer and other members of the department.

At the request of the state board of education a system of monthly reports showing progress on state educational buildings, was prepared by the state chief engineer.

The interval of one month proved to be too short a time between reports so that after different intervals were tried, it was decided to make this report a quarterly, which practice will be followed hereafter.

These reports were expanded to include all state construction and later to include a summary of the principal activities of the department of engineering.

They are issued in mimeograph form and sent to members of all boards for which the department performs service, to the executive heads of all state institutions and to the press.

The principal object of these reports is to give condensed information to the public and to those specially interested, of the progress, cost of construction and other data regarding state work coming under jurisdiction of the department.

GENERAL

The number of engineers on the staff varies slightly, from time to time, according to the amount of work in progress, and to the requirements of the department.

On September 1, 1915, just before the organization of the department of engineering, there were 82 engineers and architects and 10 engineering office employees on full time state service.

On June 30, 1916, these numbers were 87 and 11, respectively.

The increase of five in the technical staff consisted of the state chief engineer, one assistant to the state power plant engineer, one architectural draftsman, three draftsmen and engineers in the highway division. There was a decrease of one in the railroad and utilities division. This number is within the limit of regular variations in the staff, so that with practically the same force, supervisory engineering and architectural work for all state departments has been provided.

This result has been accomplished by the centralization of the state's engineering and architectural work under one department, thus making the transfer of service a matter of no difficulty. This centralization also enables the various state departments to obtain professional service with no loss in time, by application to the state chief engineer. A properly qualified member of the staff is then detailed for the special problem for which assistance is requested.

The department has been assigned permanent quarters on the third floor of the north wing of the capitol on the completion of this wing. When established in these quarters it is believed that the various services can be rendered still more efficiently. There will be closer coördination within the department, and less loss of time than under the necessary present condition of wide separation of the various divisions.

CO-OPERATION OF OTHER DEPARTMENTS

One large element in the successful working of the department of engineering has been the spirit of close coöperation shown by every department, board or commission of the state with which the department of engineering has had any relations, for which the writer wishes to express his full appreciation.

The above is not intended to be a complete summary of the work of the department of engineering but is presented as an outline of some of the important activities to show the nature of the work of the department.

A more detailed statement of the work of the department is given in the following reports of the chiefs of divisions.

In the appendix there are given condensed financial statements of the operation of the department from its organization September 1, 1915, to June 30, 1916, the end of the first biennium, as required by Section (1631—250) 8, Wisconsin Statutes 1915.

REPORT OF THE RAILROAD AND UTILITIES DIVISION

From September 1, 1915, to June 30, 1916

BY C. M. LARSON, *Railroad and Utilities Engineer*

I beg to submit herewith a brief report covering the activities of the railroad and utilities division of the department of engineering for the ten months period ending June 30, 1916. For convenience this report has been divided into three general parts, the first dealing with the work for the tax commission, the second with the work for the railroad commission, and the third with the work for all other state departments.

TAX COMMISSION WORK

Steam railroad valuation: During the period covered by this report the 1914 valuation of the physical property of all steam roads in Wisconsin was completed, as well as the 1915 valuation of the smaller roads. In carrying on this work the members of the staff revised the valuations of the larger roads, but made inspections and valuations of the smaller roads. The steam railway valuations cover over 11,000 miles of track with the real estate, terminals, structures, rolling stock, stores and miscellaneous equipment costing new over \$385,000,000. This is listed, priced and the value depreciated to correspond to its present condition.

Electric railway valuation: The electric railways also are valued each year for the tax commission. In many instances this work involves valuation of other public utility property which is combined with the electric railway property. It also involves an apportionment between electric railway and the associated utilities. Twenty-eight electric railway properties are valued at the present time, owning over 410 miles of track. These properties, including the associated utilities, cost new over \$57,000,000.

Inter-district utility valuation: Where public utilities have property in more than one assessment district, valuations of the property are made each year for the tax commission. During the spring of 1916, sixty-eight of these properties were valued, having a combined reproduction cost of nearly \$26,000,000 and a depreciated value of about \$22,000,000.

Reassessments: Reassessments were made during October and November of 1915 at De Pere, Elkhorn and Phelps. At De Pere five assessments were made covering property valued at approximately \$600,000. At Elkhorn one \$54,000 property was reassessed and at Phelps three properties with a combined approximate value of \$240,000.

Dock and warehouse valuation: The law now requires the apportionment of the railroad tax to cities in which terminal, dock and warehouse properties are located. Valuations made during the period covered by this report include sixty-three properties at Superior, Ashland, Manitowoc, Washburn, Milwaukee, Sheboygan, Green Bay, Kewaunee, Algoma and Peshtigo. The aggregate value of the property so valued was over \$14,000,000.

RAILWAY COMMISSION WORK

Public utility valuations: The work carried on for the railroad commission during the period covered by this report has been extremely varied in nature. A large amount of time has been spent on the valuation of public utilities for the purpose of adjustment of rates as well as for the issuing of securities and purchase of utility properties by municipalities.

The number of valuations of each kind of property, together with a statement of the physical value of the property involved, is as follows:

<i>Kind of Utility</i>	<i>Reproduction Cost</i>	<i>Reproduction Cost Less Depreciation</i>
19 Electric plants	\$726,798	\$556,009
2 Gas plants	59,571	54,894
4 Water plants	936,125	842,202
17 Telephone plants	387,732	270,440
2 Combined plants	281,817	237,184
Total	\$2,392,043	\$1,960,729

Distribution of work: The records of this division are kept in such a manner as to show the distribution of the work performed as far as can be done. Much is of such a general nature that it is very difficult to assign the time to any particular case. The number of cases upon which an appreciable amount of work was performed is shown in the following tabulations which are separated to show the work done on formal as distinguished from informal cases:

Valuations and Service of Public Utilities:	Formal	Informal
Electric plant cases.....	20	19
Electric safety and interference cases.....	2	13
Water plant cases	5	7
Telephone cases	20	23
Gas plant cases	2	4
Heating plant cases	1	1
Electrolysis cases	1	..
Referee meter tests .....	..	20

Steam Railroads:

Certificates of convenience and necessity....	7	..
Station and switching facilities.....	8	5
Drainage	1	3
Restoration of side tracks.....	6	1
Train service	1	..
Rates	1	..

Electric Railways:

Inspection for safety of track.....	..	2
Bridges	2	2
Accidents .....	..	1
Service	8	13

Public Safety:

Highway crossing investigations	25	54
General grade elimination plans.....	3	..

Water Power:

Valuations, flowage investigations and inspection of plans	12	14
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ROUTINE INSPECTIONS, INVESTIGATIONS AND RECORDS

Public utility service: Routine gas, electric and telephone service inspections are made throughout the state by a group of inspectors working out of Madison, Milwaukee, Appleton and Eau Claire. This work was carried on as heretofore. The inspectors investigated many informal complaints regarding service and other matters over which the commission has jurisdiction. Referee tests were made on gas, electric and water meters and facts collected in connection with railway and public utility matters. Formal orders of the commission were followed up to ascertain any violations of specific orders. The following table indicates the amount of routine inspection work performed:

<i>1915</i>	<i>Gas</i>	<i>Electric</i>	<i>Telephone</i>
September	8	21	17
October	9	54	38
November	5	21	13
December	8	44	17
<i>1916</i>			
January	6	30	14
February	5	29	32
March	7	34	51
April	2	29	28
May	4	26	36
June	10	16	22

Signals, Interlocking and Crossings:

Inspections of 86 interlocking plants for maintenance and repair
 Examination of plans of 18 interlocking plants for alterations or additions
 Inspection of 25 miles of newly installed block signals
 Examination and approval of 159 miles of proposed new block signals

Train end inspection of highway crossings on 5,000 miles of track
Investigation of reasonable charge for use of railway equipment
in crossing elimination cases

Water Power:

Daily discharge records made and compiled for 51 stream gaging stations
223 stream flow measurements made
Two new automatic gaging stations installed
Continuous gaging records received and compiled from 9 automatic stations
Power plant records received and compiled from four stations

Miscellaneous:

Compilation daily of delays to all passenger trains in the state together with causes—Report prepared monthly
Compilation of accidents reported daily or monthly by railroads
Supervision of the issuing of licenses to jitney operators in Milwaukee, Racine and Kenosha
An inspector is maintained continuously on the Wissota dam of the Wisconsin-Minnesota Light & Power Company near Chipewewa Falls
An inspection was made of a utility company to determine whether or not proper use has been made of the proceeds of sale of securities authorized by the commission
Continuous checking and issuing of schedules for street railway service in Milwaukee

The above outline of distribution of work gives no indication of the amount of time spent on any individual unit. There are some investigations that have required so much time that special mention should be made.

An entirely new valuation of all properties owned by The Milwaukee Electric Railway & Light Company and the Milwaukee Light, Heat & Traction Company was under way during the period covered by this report.

Investigations were made and plans examined for the depression of the tracks of the Chicago & Northwestern Railway Company from a point in the southern part of the city of Milwaukee to a point some distance west of Layton Park in the Town of Greenfield.

Investigations were made and plans examined for the elevation of the tracks of the Chicago & Northwestern Railway Company through the city of Kenosha.

Investigations were made and plans examined in connection with the elimination of grade crossings on the Beer Line of the Chicago, Milwaukee & St. Paul Railway in Milwaukee.

An extensive investigation was made in connection with the value of water power rights of the Wissota project of the Wisconsin

sin-Minnesota Light & Power Company. Plans for the large Wisconsin dam were examined and approval given for construction.

SERVICE RENDERED TO OTHER STATE DEPARTMENTS.

During the period covered by this report, members of the railroad and utilities division rendered service to the following departments other than the tax commission and the railroad commission:

State Board of Agriculture:

At the State Fair Park

State Board of Control:

At School for Blind, Janesville

At Industrial Home for Women, Taycheedah

At Hospital for Insane, Mendota

State Board of Education:

A valuation of various state buildings

State Board of Normal Regents:

At Superior Normal School

At Whitewater Normal School

At Stevens Point Normal School

EXPENDITURES

The amount of money expended by this division for salaries, expenses and office supplies for the ten months covered by this report, September 1, 1915, to June 30, 1916, is shown in the following tabulation:

Tax Commission.....	\$12,275.80
Railroad Commission.....	44,843.46
Other State Departments.....	534.69
Office Supplies.....	604.99
Total	<hr/> \$58,258.94

In addition to the items mentioned above, members of the staff employed in the railroad and utilities division spend a great amount of time on minor matters in carrying out routine and special requirements of the various departments. To enumerate each individual item upon which time has been so spent would require more space than is justified in a report of this nature.

REPORT OF THE HIGHWAY DIVISION

For the Calendar Year 1916

By A. R. HIRST, *State Highway Engineer*

INTRODUCTORY

The engineering staff of the Wisconsin Highway Commission came within the scope of the act creating the department of engineering, and control was taken over by this department upon the appointment of the state chief engineer, September 6, 1915. Shortly thereafter the engineer employes of the Wisconsin highway commission were reappointed as engineer employes in the highway division of the state engineering department.

This transfer occurred almost at the end of the calendar year, and at a point such that it was difficult to proportion the activities of the highway division for the year, inasmuch as the natural highway construction year is the calendar year. Therefore, by direction of the state chief engineer, this report is made for the period from January 1, 1916, to December 31, 1916, inclusive.

The figures indicating operations given in the following statement are approximate only, in most cases, due to the fact that this report is made just before the end of the calendar year and some time before the accurate figures will be assembled. All figures, however, are very close approximations and will serve the present purposes.

CHARACTER OF WORK

The work of the highway division consists of surveying, preparing plans and specifications, and supervising all state aid road and bridge construction, and a large part of the county aid bridge construction annually performed in Wisconsin. Brief reports under various heads into which this work is naturally divided follow.

CONSULTING WORK

During the year a large number of inspections and consultations were performed at the request of county boards, county highway commissioners, county state road and bridge committees, and town boards. This work consisted of general inspection of various road

and bridge projects, gravel pits and stone quarries; inspections to determine the possibility of relocations; consultations as to laying out county highway systems; in regard to bond issues, etc. Incidental to this work, employes of the division attended and gave talks at some 130 public meetings during the year.

Incidental to the general direction of the road work, was the answering of many hundred inquiries as to methods of constructing roads and bridges; statutory provisions, routes for travel; advice as to equipment, etc. This consulting service, both by visits and correspondence, is a large item of the work at the present stage of development.

STATE AID ROAD SURVEYS AND PLANS

The present state aid highway law requires that counties shall furnish the surveys and plans for all state aid road construction unless they shall request the highway division to make these surveys and repay the cost thereof into the state treasury. As a matter of fact, the highway division has, during the calendar year, on the request of the various counties, made surveys for 1208 miles of road in 61 of the 71 counties, being approximately 92% of the total mileage of the surveys made in 1916 for state aid highway construction.

Correspondingly, the division drew up and sent out plans for 1046 miles of road, during the period covered by this report. Each year in the late fall months an effort is made to survey as many miles of road as is possible, so as to get the information into the office to be worked out by the engineers during the winter months of January, February, March and April. During the fall of 1916, about 725 miles of surveys were so made, which will keep the forces of the division busy until about May 1. This will give each county for which we furnish survey and plan service an adequate number of plans on which to start construction without delay. This preparation of plans in advance is a feature of work in Wisconsin in which the state is far ahead of the practice in many other states, which seldom commence surveys for the calendar year's work until the spring preceding construction.

An accurate account is kept of the cost of surveying and getting out the plans for each separate piece of road construction, so that the cost can be charged back to the counties. The average cost of surveying a mile of road has been \$7.98 per mile, and the average cost of preparing plans has been \$16.81 per mile, giving an average cost for a complete mile of plans ready for construction of \$24.79 per mile. The actual cost varies from as low as \$5.70 to as high as \$165.55 per mile of plans, according to the difficulty of the work.

STATE AID BRIDGES SURVEYS AND PLANS

The statutes require the highway division to make all surveys and plans for state aid bridge construction without cost to the counties. During the calendar year 1916 surveys were made of 396 state aid bridge sites and plans and specifications sent out for structures at 390 of these sites. The bridge designs have been so standardized and so many of the superstructure plans are duplicates that the cost of this work has been reduced to the minimum. The average cost of surveying a bridge site and furnishing complete plans and specifications, ready for construction, has been about \$10.00 for a bridge of the average span and character.

COUNTY AID BRIDGE SURVEYS AND PLANS

The statutes require the highway division, whenever possible, to furnish free of cost to counties and towns, surveys and plans for bridges erected under the county aid bridge laws, paid for in part by the towns and in part by the counties.

In the calendar year 1916 surveys were made of 450 county aid bridge sites and complete plans and specifications sent out for 440 bridges. Inasmuch as the procedure is the same as for the surveying and designing of state aid bridges, the cost per bridge has averaged the same amount. The increasing demand for the services of the highway division as shown by the consistent advance in the amount of work done each year is the best indication of the growing appreciation by the public of the value of the engineering service in road and bridge construction. Requests for these surveys for county aid bridges are entirely voluntary on the part of the counties and towns.

STATE AID ROAD CONSTRUCTION

This year was extremely unfavorable for construction operations. The spring months were wet, succeeded by a long hot, dry spell, again succeeded by incessant rains, and an early closing in November, due to the cold weather early in that month. Added to these difficulties, both labor and teams were scarce and were to be had only at prices much advanced over those of previous years. While much of the work has not yet been tabulated, it is certain that the average cost of state road construction in 1916 was at least 10% in advance of the average for the preceding year. These conditions, however, have been met with in all lines of construction and do not occasion surprise.

Preliminary reports indicate that there has been expended in state aid road construction in 1916 the sum of \$3,631,026, and that the mileage of construction accomplished by types is as follows:

<i>Type of Road</i>	<i>Mileage</i>
Graded but not surfaced	486.5 miles
Concrete	59.01 "
Stone macadam	215.60 "
Gravel macadam	302.43 "
Other permanent surfaces	63.76 "
Nonpermanent surfaces	100.00 "
<hr/>	
Total 1916.....	1,227.30 miles

The total mileage constructed is somewhat less than in 1915, due largely to bad weather conditions, scarcity of labor, and increased costs.

STATE AID BRIDGE CONSTRUCTION

Preliminary figures indicate that there was expended in state aid bridge construction in 1916 the sum of \$540,068. There were constructed 352 bridges of all types.

The same conditions that affected road construction also adversely affected bridge construction. Here there was also the additional difficulty of obtaining steel at any price. On the whole, bridge contracts were let at surprisingly low figures, considering all conditions, and while the state of the steel market would indicate that the cost of bridge construction should have advanced at least 45%, the actual contract figures were very little in excess of 30% over those of the preceding year for the same class of structure. This was largely due to the fact that a large percentage of the bridge contracts were made early in the year and the benefit of low advance steel contracts made by the bridge companies were thus partly realized in many instances.

COUNTY AID BRIDGE CONSTRUCTION

Preliminary reports indicate that 433 county aid bridges were actually completed under the plans of the Wisconsin highway commission for the calendar year. The remarks under State Aid Bridge Construction apply with equal force to county aid bridges.

SPECIAL STATE AID BRIDGE CONSTRUCTION

During the year the bridge at Nekoosa, built under Section 1321a of the statutes was completed. This bridge is over the Wisconsin River and cost slightly over \$48,000, being 875 feet in length.

WORK FOR OTHER STATE DEPARTMENTS

During the year the highway division was of some assistance to other state commissions and departments.

For the state conservation commission road surveys were made at Devils Lake and the Peninsula State Park. Plans for one of the

roads in Devils Lake Park were furnished in the spring, and plans made from the other surveys will be furnished next spring.

Consulting services were rendered the board of control in regard to road construction at the new Industrial Home for Women at Taycheedah.

Consulting services in regard to bridges and flood conditions were rendered the railroad and utilities division on highway bridges at Eau Claire, Green Bay, Beloit, and Milwaukee.

ROAD SURVEYS FOR TOWNS

In some cases towns desiring to do especially heavy road work requested the assistance of the division in making surveys and plans for their work. About ten miles of such surveys were made during the year and the corresponding plans, etc., furnished. In order to encourage this type of work it was felt that the charges for this engineering work should be the minimum, and in some cases no charge was made.

REPORT OF THE ARCHITECTURAL DIVISION

From September 21, 1915, to December 1, 1916

BY ARTHUR PEABODY, *State Architect*

The office of state architect, filled by appointment September 21, 1915, was intended to cover the requirement for practical and advisory architectural service for the various state institutions under the state government. This contemplated the maintenance of an office where the various duties of the state architect could be performed, and the employment of a force of draughtsmen and other assistants for the preparation of such plans and designs as should be produced in the office of the state architect.

The work of the state architect during the past year and one-half, from September 21, 1915, to January 1, 1917, has consisted of three principal items:

1. The organization of the division
2. The formulation of standards in such matters as contracts, plans and specifications for labor and materials, and conduct of operations.
3. Advice and assistance to other departments and institutions of the state.

ORGANIZATION OF THE DIVISION

The item of organization was simplified by transferring to the state service a part of the force of draughtsmen, superintendents and stenographers previously employed in the architect's office of the University of Wisconsin and by making temporary use of space in the Administration Building of that institution. The facilities for production of working drawing, and specifications for new buildings were sufficiently covered for the time being, by this expedient, and until the scope of the office is enlarged, the space and staff will not need to be greatly increased. The location, away from the other departments of the department of engineering, was a disadvantage, and prevented in some measure the rapid execution of the work.

The present organization is composed of:

The State Architect

The Foreman of Draughtsmen

Two Architectural Draughtsmen

One Engineering Draughtsman

One Stenographer and Assistant to the State Architect

The state architect is further assisted by the state power plant engineer. Various architects and engineers employed by the state engineer on buildings already projected, are:

Van Ryn and De Gelleke, architects, Milwaukee, on various normal school buildings

Parkinson and Dockendorff, architects, La Crosse, on the physical education building at La Crosse

Robert Messmer and Brother, architects, Milwaukee, on the Southern Home for the Feeble-Minded and Epileptic at Union Grove

A. D. Conover, architect, Madison, on the Industrial Home for Women, Taycheedah

Foeller and Schober, architects, Green Bay, on the remodelling of the Women's Prison at Waupun

Vaughn and Meyer, engineers, Milwaukee, on engineering work for the Southern Home for the Feeble-Minded and Epileptic, Union Grove, and Industrial Home for Women, Taycheedah

W. G. Kirchoffer, consulting engineer, Madison, on various hydraulic engineering works at state institutions.

FORMULATION OF STANDARDS

The formulation of standards as to contracts, plans, specifications, structural materials and conduct of operations was begun by the preparation of a **Standard Contract** for the employment of architects on special work. This was intended to rectify conditions surrounding the previous appointment of certain architects for the preparation of plans and specifications for buildings contemplated by appropriations already made.

A **Standard Form of Contract and Bond** for the construction of public buildings in the state, together with a **Standard set of General Conditions** was formulated and applied to all new specifications and to contracts not already let.

A **Standard Form of Bid** was issued which simplified and regulated the practice of receiving proposals on work.

The form of specifications, etc., was standardized by the adoption of a page 8½" x 11" for all documents so that they could be bound in uniform size.

This resulted in assembling under one cover of the **Standard Contract, Bond, General Conditions and Specifications**.

Under the contract for the employment of architects, it was required that the original tracings and a duplicate copy of specifications should be filed with the department of engineering, from which other copies could be made at will. This freed the state government from dependence on architects in private practice for additional copies, and permitted the production at once of sufficient number of plans and specifications to secure a thorough and extensive competition and a good number of bids. It secured also

the deposit of the original drawings and specifications with the engineering department so that they could be filed in a safe place for ready reference.

The method of opening bids was standardized to secure the greatest publicity and fairness to the state and to the contractor, and to eliminate confusion when a large number of bids are to be received.

The relation of contract prices for the construction of buildings to the entire cost of a building project was clarified by the adoption of a synopsis and schedule. On this the amount of money available was set forth and subdivided under headings, to show the several cost of:

Architect' fees and expenses

Contract price for the work

Other costs incidental to the work

Balance for contingencies

To this was added a brief description and outline plans and elevations, sufficient to indicate the character of the buildings. This facilitated work when projects were to be submitted to the state board of education, or elsewhere.

The form of the architectural plans was to some extent standardized, especially as concerned the legal titles of buildings, numbering system and approval of state officers.

Further standardization of specifications and plans is contemplated, especially to secure a uniform quality of materials and excellence of workmanship for buildings of the same class.

ADVICE AND ASSISTANCE TO OTHER DEPARTMENTS

In the matter of advice and assistance to departments, the progress of work on buildings under construction by the various boards in the state government was inquired into as rapidly as possible. The state architect visited the several normal schools, penal and charitable institutions and the University of Wisconsin and made a study of conditions prevailing, and rendered such advice as could be afforded upon the basis of a preliminary survey.

His first visit was to the State Reformatory at Green Bay, where the construction of a new cell wing was begun. He looked into the matter of foundations, walls, etc., and was able to effect some economies without trenching upon the stability and good appearance of the building. He later furnished, at the request of the board of control, drawings and information as necessary during the progress of the building and, after visiting other institutions of similar character, made a report on the advantages of various arrangements of cells in buildings of this sort.

Also at their request he made a report on enclosing walls of penal institutions in the United States and advised as to the construction of an enclosing wall for the State Reformatory and fur-

nished drawings and specifications for it. None of this work is completed, but he has followed the progress of construction as necessary.

Similar work was done for the board of control for minor building operations at the Home for Feeble-Minded at Chippewa Falls, the State Prison at Waupun, and Hospital for Criminal Insane at Waupun, School for the Deaf at Delavan, School for the Blind at Janesville, the Tuberculosis Sanatorium at Wales and Tomahawk Lake Camp, State Hospitals for the Insane at Winnebago and Mendota, and for the Industrial School for Boys at Waukesha.

For new institutions, the Southern Home for Feeble-Minded and Epileptic at Union Grove and the Industrial Home for Women at Taycheedah, the state architect, in conference with the state engineer and assistant engineers, advised on the general plans for the complete development. Some modifications, especially with regard to the first of these institutions, were made to secure greater advantage of the ground, and more convenient operation. The plans and specifications, bids, contracts, etc., were carried out through the state architect's office in conformity with the standardization of documents referred to above.

Plans and specifications for an automatic sprinkler apparatus for the Northern Hospital for the Insane at Winnebago were prepared in consultation with various engineers in the state government. The cost of labor and materials being largely increased by the rise in prices since 1915 has prevented putting this work under contract at the present time.

At a meeting of the board of control for the purpose of formulating a budget, the state architect submitted a report advising as to the necessity and desirability of various building projects for the next two years.

For the board of regents of normal schools, the state architect's office assisted in the preparation of specifications, contracts and bonds for the construction of the normal school buildings at Oshkosh, Superior and La Crosse. Also advised on minor building operations at the normal schools at Whitewater, Milwaukee and Stevens Point.

At the request of the board he prepared a report upon the condition of the normal schools in the state, with recommendations for additional buildings and repairs for each, during the next two years.

For the board of regents of The University of Wisconsin he prepared contracts and bonds for the construction of the physics building and addition to soils building and has superintended the erection of these buildings to the present date. He prepared plans, specifications and contracts for the university stadium, boat and bath house, field house for women, repairs to music hall studio building, pumping station, west entrance to men's gymnasium, repairs to university hall, stock and forage barn, dairy barn exten-

sion, automatic sprinkler system for chemistry building, experimental breeding barn, hog cholera serum plant, and superintended the erection of these buildings. Also in consultation with A. R. Ross, architect, of New York City, prepared a design for the completion of the Lincoln statue. He made a report upon additional buildings and repairs in and about the university required during the next two years. During this time, also, he made preliminary designs for an administration building, remodelling of the auditorium of music hall and for men's dormitories.

For the commissioner of agriculture he advised on the location of buildings at the Milwaukee fairgrounds and the grand stand and hog and sheep pavilions.

For the fish commission, he prepared plans for a warden's cottage.

For the board of health, he made an inspection of mausoleums in Illinois and Indiana, and at Milwaukee, and submitted a report as to the character of the buildings noted. He advised as to the restrictions which should surround the quality of labor and materials entering into buildings of this character in the state of Wisconsin, and formulated an outline code for the construction of such buildings. He advised as to the fund for their maintenance and replacement.

REPORT OF THE POWER PLANT DIVISION

From October 6, 1915, to December 1, 1916

By JOHN C. WHITE, *State Power Plant Engineer*

ORGANIZATION

The regular staff of the power plant division consists of two men, the state power plant engineer and one assistant.

This division is assisted from time to time by the engineers of the railroad and utilities division, the architectural division and the consulting engineer on hydraulic and sanitary engineering. By authority of the superintendent of public property, the state power plant engineer is still charged with the duties of chief operating engineer of the capitol power and heating plant and the equipment at the capitol.

WORK

The work of the division consists of the supervision of operation of the various state plants including the purchase of fuel and supplies and the keeping of records; the preparation of plans and specifications for improvements in them and superintending construction work; investigating and advising on, and sometimes taking charge of repair work at the state institutions; examination and checking up of plans and specifications from architects and engineers, and tabulations and analyses of bids and recommendations for acceptance. Also, by direction of the board of health, where the public health or safety are concerned, this division is sometimes employed to investigate and report on other than state work, such as the heating and ventilating apparatus of public school buildings in the smaller towns.

GENERAL POLICY

It is the intention to conduct the work of the department along the following lines:

Operation—Personnel: There is probably as good average material in the operating crews as can be obtained for the salaries paid. Improvement will therefore be best accomplished by provid-

ing means for educating and instructing the present staff, and inspiring them to closer attention and greater effort, gradually supplanting those who cannot or will not respond, and encouraging those who coöperate and prove their worth by increased salaries, shorter hours in many cases, greater responsibilities and promotions where possible. To this end we have enlisted the aid of the civil service commission and through them the extension division of the university who have prepared courses well adapted to the needs of the men and the service. By the coöperation of the various governing boards these courses have been placed within the reach of all at a minimum cost. We have held one three day session of a school for chief engineers at Madison which was well attended and generally successful, and we hope to make it an annual affair.

Equipment and Supplies: The division will endeavor to operate the equipment now installed to the best advantage by examining and improving the methods and advising with the men as to proper operation and maintenance. This involves supervision of units and capacities in service for the different requirements, methods of firing, prevention and stopping of leaks, keeping of boilers and furnaces clean and in good condition, use of supplies such as lubricants, packings, etc., systematic methods of inspection and accurate keeping of records, and general cleanliness; also by assistance in perfecting the organization and defining the duties and responsibilities of subordinates. In the purchase of supplies, those best adapted to each particular requirement will be selected. Where tests or trials of new articles are desirable, it will be done with accuracy and fairness, so far as possible.

CHANGES AND IMPROVEMENTS

When necessary to make alterations in or additions to any plant, it will be done only after a careful study of the matter. It is hoped thus to secure simplicity and uniformity as far as possible, and to avoid many of the complications that now exist and out of which grow most of the troubles experienced. The division will endeavor to provide methods of securing accurate records of coal used, water evaporated and output or current purchased in kilowatt hours. Some of the plants are now equipped to secure such records and others are not so equipped. This involves the installation of devices necessary to accomplish the purpose, and the coöperation of the boards and employees in their proper care and use.

NEW WORK

Where new work is to be installed, this division will undertake it in the same manner as outlined above for changes and alterations. From his observations, it is the writer's opinion that all power and heating plant work, water supply and sewage disposal

should be designed and executed by the department of engineering. No other plan will secure such high economy in cost of operation, so great uniformity and simplicity in design, or secure the same flexibility in extension. This plan will permit the use of a considerable quantity of equipment now out of commission and stored around the different institutions. Experience with the present plants and investigations of the plans and specifications for new work now under construction support this opinion.

OPERATION OF PLANTS AND RECORDS

For some years the state board of control has retained Messrs. Vaughn, Meyer and Sweet, of Milwaukee, as consulting engineers on new work, and to superintend such changes and improvements in existing plants as were found necessary from time to time; also to supervise the operation of all plants under the control of the board. These engineers had instituted a system of station records for each institution, established a method of purchasing coal on the B. t. u. basis and made such a survey and study of the different institutions and their requirements as enabled them to make comparisons of operating records and to determine with some degree of accuracy the unit costs of each institution. Time has not permitted this division to make a re-survey of this work and it has accordingly continued the system as worked out previously, with only a few minor changes. Data covering the operation of these plants will be found in the appendix. The unit costs therein set forth are as accurate as present equipment and methods will permit.

NORMAL SCHOOLS

The board of normal regents has not as yet installed a system of station records. Their coal is bought under yearly contract, but there is no provision for determination of values and payment in accordance therewith.

The data for these plants, given in the appendix, is taken from the reports of the secretary of the board. The unit costs are based on the cubical contents of the buildings as set forth in a report by the state architect. The division has not yet obtained regular reports from the normal schools and the pressure of design, repair and rebuilding work in other state plants has not yet permitted a study of the normal school plants beyond a preliminary inspection of each, but they should be placed on the same basis as other state plants.

CAPITOL POWER AND HEATING PLANT

Previous reports on this plant have been made to the superintendent of public property and are available for use. Graphical data from the beginning of operation in regular service are available.

Unit costs for heating are not comparable for the reason that construction work on the state capitol has been in progress during all of the time and service has been furnished to the contractors in carrying on the work. With the completion of the building actual unit costs can be determined with fair accuracy.

UNIVERSITY HEATING PLANT

The results set forth in the appendix for this plant were compiled and furnished by the chief operating engineer, Mr. J. M. Smith.

OTHER INSTITUTIONS

The unit costs for the Wisconsin Veterans' Home, Stout Institute, and the School of Mines, were computed from data supplied by the officers of those institutions. All plants have been inspected at least once and a list of their major equipment and methods of operation is on file in this office. Photographic records also are on file for all of them except Stout Institute, the School for the Deaf at Delavan, and the state normal schools at Eau Claire, River Falls, Milwaukee, and Whitewater.

NEW WORK

Plans and specifications have been prepared for the following new work, all of which is under way or completed at this time:

State Prison. The boiler room has been changed and better adapted to its equipment by raising the roof over the boilers to accommodate a breeching, etc.

A new 300 horse power Stirling boiler has been installed and with it a 300 horse power Detroit Stoker, a new breeching and steam header. A Bartlett-Graver, cold, continuous process water softener has been added to the equipment and is now in service. It has a capacity of 6,000 gallons of water per hour and the water is available for use in the domestic supply to buildings and laundry as well as to boilers. The changes above noted are part of a general plan of improvement which contemplates the use of steam entirely and the abandonment of the producer gas plant. These improvements will require the erection of a permanent brick or concrete chimney, the elimination of the present steel stacks, and the providing of room for one or more 300 horse power boiler, also the necessary changes in piping and auxiliaries.

The water supply system has been redesigned and the work is now under way, but temporarily stopped on account of weather conditions. The riser pipe to the elevated tank has been repaired and reinsulated and a steam pipe has been installed to insure against freezing under extreme conditions.

Women's Ward. Heating plants for the remodeled women's ward have been prepared for the use of the state architect. This included a hot blast heating and ventilating system and direct radiation where necessary.

Hospital for the Criminal Insane. This division has investigated the shortage in water supply and referred the matter to the consulting hydraulic and sanitary engineer, Mr. Kirchoffer, for recommendation as to the best method of increasing the supply. Plans and specifications for the work will be prepared in this office under his direction.

Northern Hospital for the Insane. Plans and specifications have been prepared for a new hot blast heating and ventilating system for wards 3-4-5-6-11 and 12 south and the work is under way. Work on plans for the better heating and ventilating of the remaining portions of the main building has been begun, but the design is not yet completed.

Chippewa Falls and Wales. Plans and specifications were prepared for the installation of new domestic water heaters; these were purchased and installed. A Reiter mechanical boiler cleaner for Wales was installed. Its operation was so successful that a second one has been ordered for the other boiler.

Wisconsin Veterans' Home. The division is now working on preliminary plans for an entirely new plant at this institution. These plans will be used as a basis for an estimate of cost. A survey has been made of the property; the property lines, streets, buildings, distribution systems and topography have been mapped. A survey is being made of the physical condition of the buildings, their cubical contents, the amount of radiation installed and such other items as are necessary for a correct estimate for the requirements. Plans and estimates of cost will follow the completion of this data as rapidly as possible.

SUGGESTIONS FOR IMPROVEMENTS

The following suggestions are offered in the belief that they will enable this division to better accomplish its work and render greater service to the institutions and at a less cost:

(a) That all engineers, firemen and other power plant employees be put on an eight-hour basis and that they be required to devote a part of the free time thus secured to improving themselves in the theory and practice of their work. This should apply especially to chief engineers.

(b) That chief engineers be put on the basis of responsible agents rather than irresponsible subordinates and that they be held accountable for the proper operation and maintenance of their plants. This will insure the automatic elimination of indifference and incompetence.

(c) That this division be given sufficient help to permit making a resurvey of all institutions so that they may be properly classified

and data and records be obtained that will allow unit costs to be determined with reasonable accuracy. This method will enable the division to keep in advance with its work and to have information at once available for the use of the boards in making estimates of operating costs, and for its own use in planning new construction.

The increase in staff necessary cannot be determined exactly at this time, but it would probably include an additional engineer, an engineering chemist and an office man who would act as clerk and stenographer. If the work is handled properly such a staff will always be profitably employed in taking care of the routine of operation of the 25 or more plants, and drawing plans and specifications for improvements.

(d) That the capitol power and heating plant and the operative equipment at the capitol be put under the department of engineering, and that it be used as a training school for chief engineers at the state institutions.

That there be provided, in connection with the plant, a central depot for the storage and repairing of machinery out of commission; for laboratory work in engineering chemistry and for the testing of the various materials and devices offered for trial. This will require space for storage purposes, for a machine shop and for a laboratory.

The storage space at the plant is limited; there is a small shop equipment now in running order and suitable for most of the work to be done. The laboratory is sufficient for present needs, but some additional equipment will be necessary in order to handle all of the state work. At such time as the proposed warehouse is built on the Washington avenue side of the plant, provision should be made for above requirements; until that time the work can be handled with only slight expense for equipment and such storage rental as might be necessary.

Inspections have disclosed much good equipment scattered about various state institutions and out of commission. The necessary changes in and additions to the various institutions will, from time to time, release more of it and create new demands, some of which can be supplied from rebuilt stock.

The plan would be (as soon as storage space is provided) to have all discarded equipment shipped in to the warehouse; if worth the expense it would be repaired and made available for use; if not, it would be disposed of as scrap. The shop equipment would include the necessary tools for field work on engines, generators, pumps, etc., and the mechanics would be drilled in their use and available for such work at a considerable saving over skilled men brought in from the outside on an hourly basis.

As illustrative of the possibilities of above plan, within a year machinery and equipment out of use have been transferred and put into service at other institutions of a total value of \$1,685.00 on a second hand basis, which, if its equivalent had been purchased new, would have cost from 40% to 50% more than the figure given

The laboratory should have facilities for doing all of the routine work of the division, such as fuel, feed-water and scale analysis, oil testing, etc., and at a greatly reduced cost. Commercial laboratories charge from \$3.00 to \$5.00 per sample for a proximate analysis and bomb test of coal. The actual cost for gas and oxygen is about 10c per sample and one man can run from 25 to 30 samples per week. The state will have about that number, and the weekly charge would therefore be from \$75 to \$90. A competent man can be had for \$125 to \$150 per month, the laboratory cost would not exceed \$20 per month and the other work of the division would be provided for at practically no additional expense. A further advantage of the plans outlined above for shop and laboratory work lies in the fact that resources for both would be under immediate control and at once available without extra expense, and the delays incident to other methods would be avoided.

(e) That the division be furnished with such tools, appliances and instruments as are necessary for the carrying on of the work in all its branches. These would consist of some additional shop equipment, laboratory apparatus and plant testing and engineering instruments.

REPORT OF THE STATE SANITARY ENGINEERING DIVISION

For the Calendar Year 1916

BY E. J. TULLY, *State Sanitary Engineer*

Since the creation of the division of state sanitary engineering on December 21, 1916, full time has been devoted to sanitary engineering matters for the state board of health and the state department of engineering.

Prior to this time, the sanitary engineering matters of the state board of health, particularly the field sanitary engineering and sanitary survey matters, were attended to through the state laboratory of hygiene.

The functions of the division may be classified, for purposes of convenience and simplicity, under two general headings:

EDUCATION

SANITARY ENGINEERING

The activities comprised in the first heading are two-fold.

(a) Instructional courses given at the University of Wisconsin in water analysis, and the elements of sanitary engineering and study of water supplies in the field.

(b) Addresses given before city councils, civic organizations, clubs and mass meetings relative to the various phases of public and private water supply matters, sewage treatment and disposal, and, in brief, all matters pertinent to this division, concerned with the public health.

The greater portion of the activity of the division comprehends sanitary engineering investigations and sanitary surveys conducted for the state board of health and the state department of engineering of matters or conditions affecting public health; such, for instance, as the purification of industrial wastes for the purpose of preventing or eliminating stream pollution; and lastly on behalf of private parties offering complaints to the board, particularly with reference to conditions in bodies of water as a result of discharge

of sewage, sewage effluents and industrial wastes, or relative to public water supplies, and private supplies used as semi-public waters.

For purposes of convenient presentation the sanitary engineering investigation conducted by the division may be segregated into matters concerned with

- The development of public water supplies,
- Installation of public water supply systems,
- Purification of water supplies.

- Determination of efficiency of water purification systems:

- Slow sand filtration plants,

- Mechanical filtration plants.

- Disinfection processes:

- Calcium hypochlorite treatment,

- Liquid chlorine treatment,

- Copper sulphate treatment,

- Water softening processes,

- Surveys to determine degrees of sewage treatment necessary for communities, and the type of system essential to fulfill the sanitary requirements of local conditions;

- Installation of public sewerage systems,

- Determination of efficiency of sewage treatment and disposal systems:

- Septic and Imhoff tanks,

- Intermittent types of filtration,

- Contact filters,

- Trickling filtration units,

- Disinfection processes,

- Purification and disposal of industrial wastes,

- Studies of stream pollution,

- Epidemiological surveys, more particularly concerned with public and private water supplies.

The work in regard to purification of industrial wastes is an increasing and important branch of the general activities of the division. In all instances of this nature the waste is subjected to research to ascertain an effective and economical method of purification, consistent with the sanitary requirements of the case, and on the results of the experimental findings are based the design of the system for the treatment of the waste. The diversity of the industrial wastes dealt with is illustrated by the following classification: creamery waste, casein waste, pulp and paper waste, tannery waste, chemical wastes such as coal tar and tar products, destructive distillation of wood products and acids and alkalies, woolen waste, brewery waste, gas plant waste, dye waste, metallic and wood products waste, glue waste, rendering waste.

The educational propaganda relative to the desirability of cleaner streams has been carried on in conjunction with investigations of stream pollution and has served to effect an appreciation on the

part of officials of industrial plants of the advantages of acceptable sanitary conditions, and to foster a spirit of coöperation in connection with industrial waste problems. This is manifested by the increasing number of requests from industrial concerns and factories for advice on problems of this character. It is essential to encourage this spirit by proper application and standards.

In the effort to prevent pollution of waters, and to apply remedial measures, the results sought must be those which will secure the most effective sanitary improvement practicable. Circumstances in each case must determine the course to be pursued in regulating the use of bodies of water as the place of disposal for sewage and manufacturing wastes.

Complete unification of sanitary engineering activities in or under this division is essential to success. The work during the past year is shown in the following review.

This review is a detailed tabulation of the number of sanitary engineering investigations conducted during the calendar year. It is not intended as a detailed report, since reports of this nature, dealing with each investigation, are submitted to the State Board of Health each week. The number of matters considered by the division during the past twelve months total 117, and the number of purely field analyses aggregates 706. The tabulation indicates the number of investigations, whether concerned with water supplies, sewage and sewage effluents, industrial waste or stream pollution, or combinations of these matters. In all instances, recommendations were made in an endeavor to efficiently and economically ensure the desired result.

The state and county institutions at which sanitary engineering investigations were conducted include Mendota Asylum, in connection with sewage treatment and disposal; Dunn County Asylum, relative to sewage treatment and disposal; Wales Tuberculosis Sanatorium, concerning sewage treatment and purification of laundry waste; Winnebago County Institutions, with regard to sewage pollution of a bay of Lake Winnebago; Waupun Hospital for Criminal Insane, respecting the unsatisfactory physical character of the water supply, and the removal of iron, from the supply; Southern Home for Feeble-Minded at Union Grove, in connection with installation of a sewerage system and sewage treatment plant.

SANITARY ENGINEERING INVESTIGATIONS
CONDUCTED DURING 1916

Upon Water Supplies. Sewage and Sewage Effluents, Industrial
Waste, Stream Pollution

Month	Investigations Made	Field Survey Samples Analyzed
February	6	125
March and April	13	19
May	9	116
June	9	102
July	20	71
August	19	73
September	9	90
October	13	25
November	14	55
December	5	30
Total	117	706

LOCATIONS VISITED

Ashland	Kaukauna	Rosendale
Arcadia	Kenosha	Ripon
Bristol	Lomira	Rockfield
Beloit	Lake Mills	Sturgeon Bay
Bassett	Lamartine	South Randolph
Beaver Dam	Lake Geneva	Schleisingserville
Brandon	Mellen	Stoughton
Black River Falls	Milwaukee	South Milwaukee
Bartell	Markesan	Salem
Cedarburg	Mequon	Thiensville
Carrollville	Menomonie	Two Rivers
Elkhart Lake	Madison	Waupun
Edgerton	Muscoda	Watertown
Fairwater	North Milwaukee	Wales
Fond du Lac	North Racine	West Allis
Fredonia	Oshkosh	Whitewater
Germantown	Plymouth	Waukesha
Grafton	Platteville	Waterloo
Hamilton	Rhineland	Wauwatosa
Hartford	Racine	Wausau
Iron Ridge	Randolph	

Concerning plans as to future development, it is believed that the division affords an opportunity to accomplish desirable, important and effective administrative work relative to the operation of water purification plants and sewage treatment and disposal systems, and the correlation of statistical data as to such plants and systems. Work of this nature has been initiated and the purpose

is to make it as comprehensive as possible. It is the intention to make efficiency runs on the water purification plants of the state, with a view to determining the measures to be taken, to maintain effective operation of such units, and, thus, to ensure a uniformly safe and acceptable water supply.

It is also purposed to conduct investigations of the number of sewage treatment and disposal systems of each type, so that data may be available as to the effectiveness of the different types under different conditions. This will be done partly with a view to stimulating concerted efforts to improve the operation of existing plants, which in many cases are given but very little attention; in fact, are neglected. This tendency on the part of municipal authorities to slight the work connected with sewage treatment plants, should be corrected. It, therefore, appears that considerable discretionary power should be given to the state board of health in regard to the operation of both water purification plants and sewage disposal systems in order to secure the fulfillment of public health requirements.

The educational work of the division bearing upon the value to a community of a public water supply and a water carriage system of sewage disposal is being regularly conducted in conjunction with the other work of the division. The prospect of installation of public water supplies or sewage disposal systems, or both, in various municipalities, together with measures for the protection of public water supplies, indicates an intention on their part to coöperate with the state board of health in the effort to improve public health.

WORK DONE BY W. G. KIRCHOFFER DURING 1916 FOR THE DEPARTMENT OF ENGINEERING

STATE INSTITUTIONS

Industrial Home for Women, Taycheedah: Design and supervision of work on water supply, sewerage and land drainage.

Home for Feeble-Minded, Chippewa Falls: Inspected water supply and sewage disposal and made recommendations as to the improvement.

State Prison, Waupun: Supervision of farm drainage, consisting of drain tile on area of 140 acres.

Hospital for Criminal Insane, Waupun: Report on additional water supply and removal of iron.

Northern Hospital for Insane, Winnebago: Inspection of sewage disposal and water supply with recommendations for improving the sewage disposal plant by the addition of sprinkling filters.

Southern Home of Feeble-Minded, Union Grove: Survey, plans and supervision for sewers and drainage, including main outlet sewer, two miles in length.

Sanatorium, Wales: Supervision of installation of tank and lime treatment for laundry waste.

Asylum for Insane, Mendota: Inspection of sewage disposal with report recommending the addition of sprinkling filters.

Wisconsin Veterans' Home, Waupaca County: Survey and map of grounds with estimate of improvements on sewers and sewage disposal.

Tomahawk Lake Camp: Inspection of water supply and sewage disposal; the rebuilding of the filters and sketches and estimates for a root cellar.

State Reformatory at Green Bay: Survey and plans for drainage of park area with designs and recommendations on foundations for new concrete wall.

State Fair Park, West Allis: Survey and plans for relocation of buildings and drainage, now in process of completion.

State Board of Health: Plans for sewerage systems and improvements to sewage disposal plants have been approved at the following places:

Cashton	Denmark	Elkhart Lake
Embarrass	Kohler	Mt. Horeb
Mayville	Monticello	New Glarus
New Lisbon	Oconto Falls	Plymouth
Randolph	Whitewater	Waterford

Plans for water works plants have been approved at the following places:

Albany	Belleville	Cornell
Mellen	New London	Nekoosa
Oshkosh	Wittenberg	Marshfield

Plumbing Division of State Board of Health: Assistants have made a large number of drawings for sewage disposal plants for residences, private institutions, hotels, factories, etc., and have made drawings for the use of plumbing inspectors and their work.



APPENDIX

DATA IN CONNECTION WITH THE REPORT OF THE STATE POWER PLANT ENGINEER

STATE BOARD OF CONTROL

Unit costs for combined heating and electric service for all purposes; this includes fuel, labor, repairs and supplies and is computed from data furnished by the Board.

Institution	Contents buildings, cu. ft.	Total expendi- tures	Cost per cu. ft.
Mendota State Hospital.....	3,730,000	\$23,581.12	\$0.00331
Northern Hospital	3,260,748	18,033.04	.00564
School for Deaf.....	1,832,906	9,021.24	.00492
School for Blind.....	1,403,134	7,634.00	.00544
Industrial School for Boys.....	1,543,709	10,851.67	.00704
State Prison	5,080,500	32,200.84	.00333
State Public School.....	710,096	9,141.78	.01289
Home for Feeble-Minded	4,170,000	26,355.94	.00631
State Reformatory	3,439,589	11,660.24	.00339
Tuberculosis Sanatorium	760,350	15,244.84	.02000
Hospital Criminal Insane.....	521,200	5,481.21	.01052
Tomahawk Lake Camp.....	(*).....	(*).....	(*)....

* Insufficient data.

Continuous 24 hour daily service is furnished at all of above except the schools for the deaf and for the blind; these have a short vacation period in the summer during which there is some reduction of service. The work includes the heating and lighting of buildings, power for all purposes and steam for cooking and laundry work. In most cases refrigeration is furnished also.

In comparing the above figures, consideration should be given to the purpose of the institution and the nature of the service rendered; there is a valid reason why it should cost more at Wales and Sparta than at some of the others. Also it is not known how much of the total space given above is furnished with 24 hour service; for instance, at the Hospital for Criminal Insane, all of the space is given continuous service, while at the prison and reformatory much of it is required only during the working day. There is a difference between the cost of service to shops and buildings used only in daytime and those used as quarters and which must be given 24 hour service. There are also some warehouses included which are given practically no service. A further survey and study of the matter is necessary in order to arrive at a proper estimate.

STATE NORMAL SCHOOLS

Unit costs for Heating and for Electric Current for lighting and power, 1915-1916. From the expenditures as given in the 1916 report of the Board, and the cubic contents of the buildings as set forth in the report of Arthur Peabody, State Architect.

Institution.	Total space cubic feet.	Power Plant Expenditures.		Heating cost per cubic foot.	Electric cost.	Total cost.
		Heating, fuel and labor, etc.	Electric current.			
Eau Claire	1,998,180	Not in use	.....(†)....	.....	.....	.....
La Crosse	1,727,960	\$4,378.11	\$1,695.40	\$0.00253	\$0.00068	\$0.00351
Milwaukee	2,885,831	6,823.33	1,870.13	.00237	.00065	.00302
Oshkosh*	2,502,477	9,355.37	.....(†)....	.00374	.....	.00374
Platteville	1,551,346	4,930.97	438.00	.00318	.00028	.00346
River Falls	1,684,736	5,301.75	751.30	.00313	.00043	.00356
Stevens Point	1,988,025	5,855.60	951.79	.00295	.0.048	.00343
Superior	1,412,347	4,441.31	1,198.88	.00314	.00085	.00399
Whitewater	1,605,954	4,235.03	484.88	.00264	.00030	.00294

* Oshkosh is not fairly comparable on account of the break caused by the fire.

† No data available.

‡ Has power plant.

The service of the Normal Schools is not continuous, daily twenty four (24) hour service as in the case of most other state institutions. Also it is different in character, there being no collective living at any of them, except perhaps the few dormitories which are run independently and are not included in above. The buildings are unoccupied for more than 50% of the time, and, while they can not be treated as entirely vacant, the service can be greatly curtailed during that period.

CAPITOL POWER AND HEATING PLANT

UNIT COSTS FOR STEAM AND

ELECTRIC SERVICE

1915-16

The total expenditures for operation at both plant and Capitol are given in the report of the Superintendent of Public Property at \$40,765.89. From this should be deducted those items which would appear whether service is produced or purchased, in order to determine the cost of production. Included in such deduction are:

The entire salaries of the engineers at Capitol.....	\$3,000.00
7/8 of the salary of the electrician	1,261.25
7/8 " " " " " " plumber	1,085.84
1/2 " " " " " " machinist	529.99
1/2 " " " " " " steam-fitter	536.25

\$6,413.33

There are some other items which should be apportioned, such as lubricants, packings, etc., but they are not of sufficient amount to affect results and cannot be determined accurately at this time.

\$40,765.89
6,413.33

Total expenditures for production.....\$34,352.56

The investment charges will be taken as heretofore, at eight per cent on a total investment in plant and tunnel of \$506,242.00, making on annual charge of \$40,499.36.

APPORTIONMENT

From a careful analysis the operating and investment charges have been apportioned for previous reports as follows, and I see no reason for making any changes now:

<i>Operation</i>		<i>Investment</i>	
Steam	75.7%	Steam	57.2%
Electric	24.3%	Electric	25.00
		Other uses	17.80

The output in kilowatt hours for the period was 1,394,819. The total water evaporated into steam at 140# pres. 110,406,810 lbs.*

Based on the foregoing percentage apportionments the amounts chargeable to the different services become:

<i>Operation</i>		<i>Investment</i>	
\$34,352.56x75.7%=\$26,004.88		\$40,499.36x57.2%=\$23,165.64	
34,352.56x24.3 = 8,347.68		40,499.36x25.0 = 10,124.84	
		40,499.36x17.8 = 7,208.88	

UNIT COSTS

STEAM

<i>Operation</i>		<i>Investment</i>	
\$26,004.88		\$23,165.64	
Per M lb. $\frac{\quad}{110,407}$ =23.554c		Per M lbs. $\frac{\quad}{110,407}$ =20.98c	
Total cost per 1,000 lbs.....	44.534c		

ELECTRIC

<i>Operation</i>		<i>Investment</i>	
\$8,347.68		\$10,124.84	
Per Kw hour $\frac{\quad}{1,394,819}$ =59.85c		Per Kw hour $\frac{\quad}{1,394,819}$ =.74c	
Total cost per Kw. hour.....	1.3785		

*Water evaporated is 90% of that accounted for by the meters, to cover leakage and errors, meter readings showing 122,674,243 lbs.

SPACE SERVED

Total contents of Capitol enclosing walls, external measurements, as computed from architects' drawings, and including only that space that is heated and furnished with other service:

Capitol Building.....	7,656,842	cu. ft.
Tunnel	169,727	" "
Power Plant.....	959,000	" "
Total	8,785,569	" "

COSTS PER CU. FT.

The purpose of the plant is to serve the Capitol and its value depends on the cost of production. This should therefore be computed from the net space served and the operating cost.

\$34,352.56

7,656,842

=.4486c

This cost is comparable with

those given for the other state institutions, no investment charges being included in either case.

The service is continuous 24 hour daily service, and includes everything used—heat, light, power and water. It is somewhat different in character from the others, the power and lighting loads being much heavier.

DATA ON COSTS AT UNIVERSITY HEATING AND POWER PLANT

Biennium from July, 1914, to June, 1916

	1914-1915	1915-1916
Total expenditures for electric current....	\$18,205.86	\$14,696.68
Kilowatt hours	778,600	823,700
Cost per kilowatt hour.....	2.34	1.79
Total expenditure for heat and water.....	\$108,363.93	\$82,596.90
Approximate cost for heating only.....	73,000.00	54,800.00
Square feet of equivalent radiation.....	264,190	265,515
Cubical content of buildings heated from central plant	27,681,700	27,756,700
Average cost heating per sq. ft. radiation per year	27.6c	20.7c
Average cost of heating per cubic foot cubical content per year.....	0.264c	0.198c

UNIVERSITY HEATING AND POWER PLANT

**Report of Coal Consumed and Water Evaporated for year from
July, 1914, to June, 1915**

<i>Month</i>	<i>Total of Reading of Venturi Charts</i>	<i>Tons of Coal Consumed</i>	<i>Evaporation Water—Coal</i>
July	2,746	559.3	7.56
August	1,706	418.6	6.29
September	2,110	495.15	6.57
October	6,426	1,185.35	8.35
November	11,903	2,250.9	8.16
December	15,840	3,302.3	7.4
January	16,516	3,389.5	7.5
February	13,295	2,781.45	7.37
March	13,508	2,619.0	7.95
April	6,765	1,108.1	9.4
May	5,313	957.9	8.55
June	2,364	572.8	6.37
Total	98,492	19,640.35	

Constant of Venturi Meter is 3080; i. e. Reading X Const.=Pounds

Total pounds of water for year=303,355,360

Total pounds of coal per year=39,280,700

Evaporation for year=7.723 pounds water per pound coal

UNIVERSITY HEATING AND POWER PLANT

**Report of Coal Consumed and Water Evaporated for Year
from July, 1915, to June, 1916**

<i>Month</i>	<i>Total of Reading of Venturi Charts</i>	<i>Tons of Coal Consumed</i>	<i>Evaporation Water—Coal</i>
July	1,895	506.05	5.78
August	1,316	389.0	5.22
September	2,637	607.4	6.69
October	5,892	1,202.1	7.55
November	10,313	1,997.45	7.98
December	13,849	2,811.8	7.58
January	16,238	3,275.2	7.65
February	14,876	3,004.7	7.63
March	14,584	2,903.0	7.73
April	8,979	1,681.7	8.23
May	5,654	1,008.35	8.7
June	4,090	652.65	9.65
Total	100,323	20,039.4	

Constant for Venturi Meter is 3080; i. e., Reading X Const.=
Pounds

Total pounds of water per year=308,994,840

Total pounds of coal for year=40,078,800

Evaporation for year=7.725 pounds water per pound coal

WISCONSIN MINING SCHOOL

PLATTEVILLE

**Information Compiled from the Records of Costs of Operation
of Heating, Lighting, Power, and Water Service,
July 1, 1915, to July 1, 1916**

Fuel	\$1,222.23
Current generated.....	none
Current purchased	301.17
Water purchased	81.43
Water pumped on premises	no measure
Repairs and maintenance	45.20
Supplies	33.39
Engineer	330.88
Extra labor	19.95
<hr/>	
Total cost	\$2,034.25
Cubic feet heated	850,000
2034.25	
Unit cost= $\frac{2034.25}{850,000} = \0.0024 per cubic foot	

STOUT INSTITUTE

UNIT COSTS

Expenditures 1915-16

Fuel, 2735 tons of coal.....	\$11,502.45
Current generated, 136,800 kw. hours	
Current purchased	524.99
Water pumped	None
Water purchased	1,496.01
Repairs and maintenance	222.52
Supplies purchased	245.48
Chief engineer and regular assistants.....	3,729.12
Extra labor	1,004.00
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Total	\$18,724.57

The space served is given in Mr. Peabody's report as 2,340,940 cubic feet.

Taking the 2,340,940 cu. ft. as being more nearly correct, the unit cost for all services becomes, $\frac{18,724.57}{2,340,940} = \0.008 per cu. ft.

WISCONSIN VETERANS' HOME

UNIT COSTS

Expenditures 1915-16

Fuel, estimated, 4700 tons of coal.....	\$23,500.00
Maintenance, estimated	1,700.75
Supplies purchased, estimated	350.00
Labor, chief engineer and regular assistants.....	4,200.00
Extra labor, estimated	500.00
Total	<u>\$30,250.75</u>

The cu. ft. of space served as figured from our recent survey and from information furnished by Mr. Port, Chief Engineer at the home, is 2,023,670 from which the unit cost is computed at \$0.0149 per cu. ft.

This plant furnishes all services, water for general service and fire protection, domestic hot water supply, steam for heating and electric current for all lighting and power purposes; also sewage disposal. There are about 103 buildings, some 90 of which have service. They are mostly small wooden buildings which increases the demand for heat. All have 24 hour daily service.

FINANCIAL STATEMENT OF THE DEPARTMENT OF ENGINEERING

EXPENDITURES

Sept. 1, 1915, to June 30, 1916

(Section 172—129 W. S. 1915)

Salary of state chief engineer.....	\$4,916.65
Salaries and wages:	
Experts	5,742.65
Office employees	1,129.71
Traveling and field expenses	265.68
Stationery and office supplies.....	177.52
Postage	125.46
Telephone and telegraph.....	67.84
Express, freight and drayage	3.18
Printing and binding reports.....	72.48
Miscellaneous supplies and expense.....	55.81
Total	<u>\$12,556.98</u>

SALARIES AND EXPENSES MEMBERS OF THE STAFF OF
THE DEPARTMENT OF ENGINEERING CHARGED
TO OTHER STATE DEPARTMENTS,
BOARDS AND COMMISSIONS

September 1, 1915, to June 30, 1916

	<i>Salaries</i>	<i>Expenses</i>	<i>Total</i>
University of Wisconsin	\$1,620.32	.....	\$1,620.32
State board of education.....	70.90	.....	70.90
Wis. Geo. & Nat. History Survey....	654.76	.....	654.76
Railroad Commission.....	23,289.69	\$3,868.63	27,158.32
Tax Commission	7,423.77	819.50	8,243.27
Highway Commission	31,008.59	4,322.26	35,330.85
State board of health.....	21.49	40.14	61.63
Department of agriculture	7.50	.....	7.50
Capitol Commission	138.00	.....	138.00

Board of Regents of Normal Schools:

Eau Claire Normal School.....	.....	.....	.....
La Crosse " "	\$10.61	\$11.20	\$21.81
Milwaukee " " .....	.....	2.59	2.59
Oshkosh " "	148.94	63.50	212.44
Platteville " " .....	.....	14.29	14.29
River Falls " " .....	.....	8.64	8.64
Stevens Point " "	36.16	.....	36.16
Superior " "	138.52	.....	138.52
Whitewater " "	84.74	12.33	97.07
Total " "	\$418.97	\$112.55	\$531.52

State Board of Control Institutions:

Chippewa Falls.....	\$88.07	\$27.94	\$116.01
Delavan	105.29	9.50	114.79
Green Bay	82.58	63.22	145.80
Janesville	134.78	35.24	170.02
Mendota	221.30	2.70	224.00
Milwaukee (workshop) .....	.....	.....	.....
Sparta	17.09	5.43	22.52
Taycheedah	106.87	14.77	121.64
Tomahawk Lake Camp .....	.....	.....	.....
Union Grove	701.21	36.25	737.46
Wales	560.29	87.89	648.18
Waukesha	296.32	69.16	365.48
Waupun—hospital	79.60	6.71	86.31
Waupun—prison	262.88	54.19	317.07
Winnebago	217.49	24.36	241.85

Total, Bd. of Control.....	\$2,873.77	\$437.36	\$3,311.13
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RECAPITULATION SALARIES AND EXPENSES

September 1 1915, to June 30, 1916

	<i>Salaries</i>	<i>Expenses</i>	<i>Total</i>
Dept of Engineering (172-129) ..	\$11,789.01	\$265.68	\$12,054.69
Board of Regents of Normal Schools	418.97	112.55	531.52
State Board of Control	2,873.77	437.36	3,311.13
University of Wisconsin	1,620.32	.....	1,620.32
State Board of Education	70.90	.....	70.90
Wis. Geo. & Nat. History Survey ..	654.76	.....	654.76
Railroad Commission	23,289.69*	3,868.63*	27,158.32*
Tax Commission	7,423.77*	819.50*	8,243.27*
Highway Commission	31,008.59*	4,322.26*	35,330.85*
State Board of Health	21.49	40.14	61.63
Department of Agriculture	7.50	.....	7.50
Capitol Commission	138.00	.....	138.00
	<hr/>	<hr/>	<hr/>
	\$79,316.77	\$9,866.12	\$89,182.89

*Figures for railroad and tax commissions and for the highway commission cover only that portion of the period September 1, 1915, to June 30, 1916, after the staff was formally taken over by the department of engineering—approximately January 1, 1916.

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